

CLAIMS:

1. An electronic device comprising a first circuit element and a second circuit element, which are connected by bonding-bumps structure, said bonding-bumps structure comprising:
- 5 a pedestal portion comprising gold and formed on a circuit element;  
a barrier layer formed on the pedestal portion;  
a soldering portion formed on the barrier layer, the soldering portion comprising a first layer comprising gold, a second layer comprising gold, and an intermediate layer comprising tin and located between the first and second layers;
- 10 wherein the relative masses of gold and tin in the soldering portion are such that the composition of the soldering portion corresponds to the eutectic gold-tin composition.
- 15 2. The device of claim 1, wherein the height of the pedestal portion is of the order of  $30\mu\text{m}$ .
3. The device of one of claims 1 or 2, wherein the thickness of the first layer of the soldering portion is in the range  $1.0$  to  $1.3\mu\text{m}$ , wherein the thickness of the second layer of the soldering portion is in the range  $0.7$  to  $0.8\mu\text{m}$ , and wherein the thickness of the intermediate layer of the soldering portion is in the range  $1.5$  to  $1.8\mu\text{m}$ .
- 20 4. The device of one of claims 1, 2 or 3, wherein the thickness of the first layer of the soldering portion is approximately  $1.15\mu\text{m}$ , wherein the thickness of the second layer of the soldering portion is approximately  $0.75\mu\text{m}$ , and wherein the thickness of the intermediate layer of the soldering portion is approximately  $1.65\mu\text{m}$ .
- 25 5. The device according to any one of claims 1 to 4, wherein the height of the bonding-bump is of the order of  $35\mu\text{m}$ , and the diameter thereof is of the order of  $60\mu\text{m}$ .
- 30 6. The device according to any one of claims 1 to 5, wherein the bump structure is formed on a monolithic microwave integrated circuit.

7. A method of forming a bonding-bump structure for a device according to any one of claims 1 to 5, the method comprising the steps of:

(a) forming a titanium seed layer on the circuit element;

(b) removing portions of the seed layer at locations corresponding to contacts

5 (P) on the circuit element;

(c) performing a controlled electroplating process to successively plate, at the locations corresponding to the contacts on the circuit element, the pedestal portion, the barrier layer, the first layer comprising gold, the intermediate layer comprising tin, and the second layer comprising gold;

10 (d) removing the remaining portions of the titanium seed layer.

8. A bonding-bump formation method according to claim 7, wherein step (b) comprises:

forming a mask layer on the titanium seed layer, and patterning the mask layer to define at

15 least one opening; and

removing the titanium seed layer portion(s) exposed in the at least one opening.

9. A bump-bonding method of connecting a first and a second circuit element, the method comprising the steps of:

20 forming at least one bonding-bump according to any one of claims 1 to 6 on a surface of the first circuit element;

bringing the first and second circuit elements into a facing relationship, with the at least one bonding bump contacting the surface of the second circuit element; and

25 applying heat at a temperature corresponding to the gold-tin eutectic temperature.

10. The electronic device of one of Claims 1 to 6, wherein the first circuit element is constituted by an integrated circuit and the second circuit element is constituted by a  
30 second integrated circuit or by a substrate, which are connected by bonding-bumps according to Claim 9.

11. A mobile terminal comprising an electronic device as claimed in Claim 10.